

Protecting Astronaut Health at First Entry into Vehicles Visiting the International Space Station: Insights from Whole-Module Offgas Testing

NASA has accumulated considerable experience in offgas testing of whole modules prior to their docking with the International Space Station (ISS). Since 1998, the Space Toxicology Office has performed offgas testing of the Lab module, both MPLM modules, US Airlock, Node 1, Node 2, Node 3, ATV1, HTV1, and three commercial vehicles. The goal of these tests is twofold: first, to protect the crew from adverse health effects of accumulated volatile pollutants when they first enter the module on orbit, and secondly, to determine the additional pollutant load that the ISS air revitalization systems must handle. In order to predict the amount of accumulated pollutants, the module is sealed for at least 1/5th the worst-case time interval that could occur between the last clean air purge and final hatch closure on the ground and the crew's first entry on orbit. This time can range from a few days to a few months. Typically, triplicate samples are taken at pre-planned times throughout the test. Samples are then analyzed by gas chromatography and mass spectrometry, and the rate of accumulation of pollutants is then extrapolated over time. The analytical values are indexed against 7-day spacecraft maximum allowable concentrations (SMACs) to provide a prediction of the total toxicity value (T-value) at the time of first entry. This T-value and the toxicological effects of specific pollutants that contribute most to the overall toxicity are then used to guide first entry operations. Finally, results are compared to first entry samples collected on orbit to determine the predictive ability of the ground-based offgas test.